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SOUTH SASKATCHEWAN RIVER DEVELOPMENT PROJECT

*Canada, Agriculture Dept.
Prairie Provinces Relations Admin.
Information Publications*

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LS-13



THE PURPOSE

1. Stabilize agriculture in the region through irrigation and provision of more dependable water supplies.
2. Provide hydro-electric power.
3. Provide a more abundant supply of good water for domestic and industrial purposes.
4. Reduce flood hazards on the river through better river regulation.
5. Create greater facilities for recreation.

HISTORY

July 25, 1958!

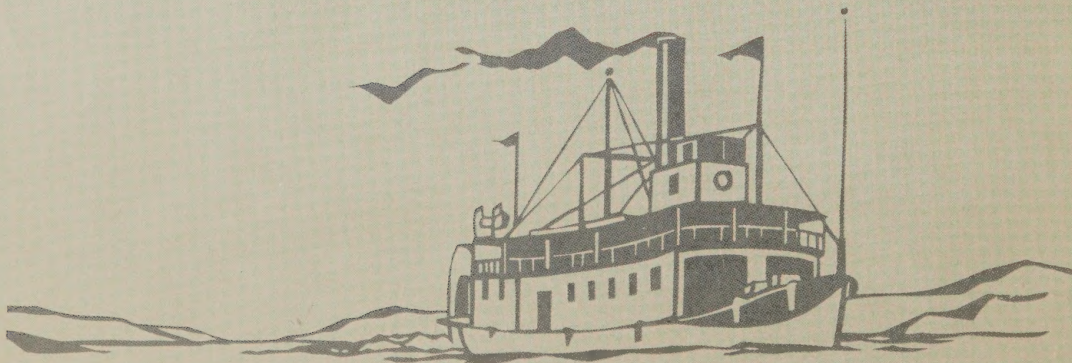
This is an important date because it brought the dream of damming the South Saskatchewan River—a dream that has persisted for 100 years—into the world of reality. On this date, an agreement was signed by the Government of Canada, previously ratified by the Government of Saskatchewan, authorizing construction of the South Saskatchewan River Project.

AN EARLY VIEW

In 1857 the British Government sent an expedition under Captain Palliser to explore Western Canada. The next year the Government of Canada sent an expedition under Professor H. Y. Hind of Trinity College to explore the Assiniboine and Saskatchewan River Valleys. Both explorers noted the close interrelationship between the valley of the South Saskatchewan and the Qu'Appelle lake and river system. Palliser suggested the feasibility of a navigable route connecting the two valleys; Hind thought a dam should be built across the South Saskatchewan to direct its waters down the Qu'Appelle Valley. But, with the Canadian Pacific completing its trans-continental railway in 1885, the concept of a water route to the west faded.

URBAN AREA EXPANSION

Sixty years ago when Regina and Moose Jaw were fast-growing centers, along with several smaller communities, serious water shortages were experienced. Again the idea of a dam across the South Saskatchewan became the talk of the early 1900's. Subsequent representations to Government for the construction of a dam to direct some water from the South Saskatchewan River into Buffalo Pound Lake and augment their meagre supply were heard, but the proposed project was considered too costly. This situation continued until 1954 when PFRA was authorized to construct works for pumping water from the South Saskatchewan River over a divide into the Qu'Appelle Valley to feed Buffalo Pound Lake used as a source of water supply for the two cities.





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DROUGHT

In 1935 the Government of Canada established the Prairie Farm Rehabilitation Administration, now popularly known as PFRA, to find ways and means of overcoming drought on the prairies and to alleviate the depressed conditions which resulted.

In 1939, PFRA had carried out extensive studies and surveys to determine the soundness of using existing water resources to meet these needs. In that year they launched a study of the William Pearce proposal ^{1/} with surveys more particularly directed toward the possibility of irrigating some specific areas in Alberta with a possible extension into western Saskatchewan. In the findings of this survey, some of the soils were unsuitable for irrigation, and the proposed extension into Saskatchewan presented some major physical difficulties. Certain modified versions of this proposal, however, are still under consideration.

In 1943, PFRA began a study to determine the feasibility of diverting the South Saskatchewan River well inside the Saskatchewan boundary, and creating a storage reservoir near the area of need. This would eliminate building lengthy and costly artificial waterways and, at the same time, would make water available for other existing needs. Ten different sites along 100 miles of the South Saskatchewan River were investigated before the present site was chosen as being the most suitable.

In 1947, PFRA filed a report indicating a choice of site, the feasibility of construction, an estimate of the cost, and descriptions of the benefits which could be derived from the project.

TIME FOR ACTION

Early in 1958 the Government of Canada entered into negotiations with the Province of Saskatchewan to proceed with the project as outlined in the PFRA report and an agreement was signed before the end of that year. The cost of construction is to be shared by the two governments with Canada paying 75 per cent and Saskatchewan 25 per cent, with the Province's share limited to \$25,000,000. Upon completion, Canada is to maintain the works for a period of 10 years, and be responsible for the cost of such maintenance for a period of six years. During the remaining four years, the cost is to be shared equally.

The agreement also stipulates that when Saskatchewan proceeds with the construction of hydro-electric power facilities, the cost of these is to be borne by Saskatchewan except that Canada shall contribute 25 per cent of the cost of constructing and installing such penstocks as may be necessary to produce 200,000 h.p. at minimum operating head. Saskatchewan also agrees to assume full responsibility for, and undertake the construction, operation and maintenance of all the irrigation works required for the conveyance and distribution of water to all lands to be irrigated by the reservoir.

^{1/}By 1919, engineer-land surveyor Pearce made study of diverting water for irrigation from the North Saskatchewan, Clearwater and Red Deer rivers. Department of Interior survey in 1920 confirmed Pearce proposal that a tract of land in the Youngstown-Hanna district in Alberta and another in Rosetown-Outlook-Saskatoon area in Saskatchewan be irrigated. Survey established the physical practicability but the project was not considered to be economically feasible at that time.

SOUTH SASKATCHEWAN RIVER PROJECT

THE DAM

The dam, which is located midway between the towns of Outlook and Elbow, is the largest rolled-earth fill of its kind in Canada. In fact, it ranks as one of the largest of its type in the world, rising 210 feet above the river bed and stretching about 3 miles across the valley.

The diversion works for the dam contained the flow of the river while the main embankment was under construction. These consist of 5 concrete tunnels, each 4,300 feet long and 20 feet in diameter, built in bedrock through the west bank of the dam. Eventually, the tunnels will serve a power station being built at the site, and regulate the downstream flow from the reservoir.

The spillway, located on the west bank of the river, is of reinforced concrete, gated, and utilizes a natural depression in the area. The spillway is 17,000 feet long, including an 8,000-foot approach, a 3,000-foot concrete control structure, and a 6,000-foot exit channel.

A second dam, about 12 miles southeast of the town of Elbow, controls the flow of water from the South Saskatchewan River Reservoir into the Qu'Appelle Valley. This dam is 90 feet high, 10,200 feet long and 1,900 feet wide at its base. Water in the reservoir at this point will be 70 feet deep at full supply level.

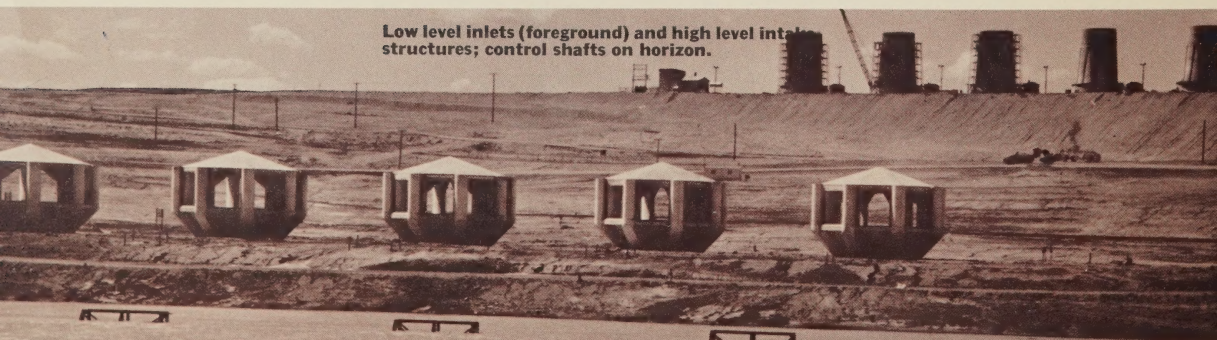
THE RIVER

The South Saskatchewan River begins in the Rocky Mountains, flows east to Elbow and then swings sharply northward through Saskatoon to join the North Saskatchewan some 30 miles east of Prince Albert. From here, it flows east to Lake Winnipeg and eventually empties into Hudson Bay.

In the plains region, the South Saskatchewan River flows through a deeply entrenched valley with a relatively flat gradient. The depth of the valley has been the main deterrent to development in the past because of the high cost of dam construction. On the other hand, the deep valley and flat gradient provide a large storage area which has made multiple-use development possible.

THE RESERVOIR

The main reservoir of the South Saskatchewan River Project is capable of impounding 8,000,000 acre-feet of water. It is 140 miles long, 192 feet deep at the dam, and has a shoreline of 475 miles, making it the largest lake in the Canadian central plains. About 109,600 acres of land in the reservoir will be flooded. Of this, 5.2 per cent was previously under cultivation. The remaining land is immediately adjacent to the river and was mainly used for grazing.



PROGRESS OF CONSTRUCTION

With construction now entering the ninth year on the South Saskatchewan River Development Project, the shape and dimension of the project has emerged as work forces press forward on the final stages of construction. Scheduled for completion in 1967, emphasis in construction has been focussed mainly on the building of the dam on the South Saskatchewan River located midway between the towns of Elbow and Outlook. To carry out this work, a total of 57 contracts have been awarded, valued at \$111.5 million, of which \$106 million have been expended.

Construction activity at the Gardiner Dam began in the late fall of 1958. The initial requirements were roads to provide access into the area and headquarters facilities at the site to accommodate P.F.R.A. engineering and administrative personnel supervising construction of the project. This work was carried out during the first winter.

In November (1958), a contract for processing and stockpiling aggregate required in concrete, got under way. In mid-December, work was started on the piers for a construction bridge to provide a means by which men and equipment might cross the river.

Work on the embankment began the following spring. Because of the magnitude of the structure, and the nature of the valley, the embankment was developed in several stages. This involved raising the embankment to progressively higher elevations on either side of the river, while steadily narrowing the channel between the two abutments in preparation for the time when the river could be closed off entirely, and the water redirected via five diversion tunnels.

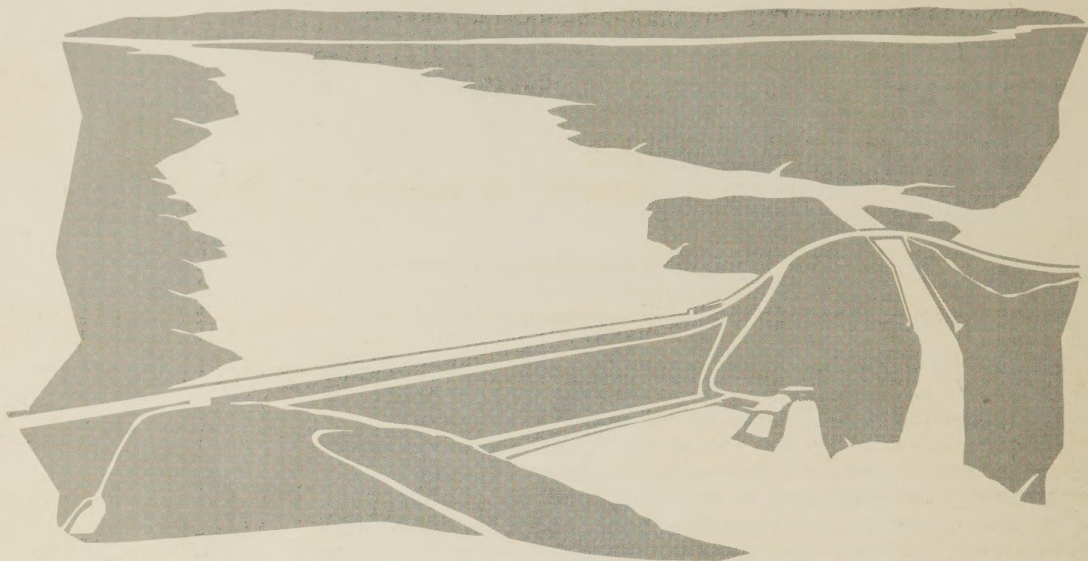
The job of building the tunnels took approximately four years (1960-64). Mechanical mining equipment, including an excavating unit commonly referred to as a "Mole," was used in the tunneling operation. The tunnels were mined to a diameter of 25 feet, and the walls shored with steel ring beams. These beams were placed at approximately 30-inch intervals throughout the more than four miles of tunnels. A concrete lining 2½ feet thick was applied the entire length of the tunnels, bringing their inside diameter when completed, to 20 feet. The three tunnels to be used for hydroelectric power production were equipped with steel liners downstream from the control gates.

The multi-purpose function of the tunnels necessitated the installation of intakes at two elevations. The low level intakes were temporarily required to divert the river's flow during the latter period of construction. These intakes have been plugged off and permanent intakes placed higher on the embankment now carry the flow. They also prevent tunnel silting problems and assure clean water, free of abrasive material, for the power turbines.

Each tunnel is equipped with control gates to regulate discharges. These gates are situated close to the centre line of the embankment. Shafts were excavated from the top of the dam, and extend down 220 feet to intersect the tunnels. On top of the shafts, five cone-shaped concrete structures house the hoists which raise and lower the gates as required. The essential work to make the tunnels and gates operative was completed early in 1964, and the actual diversion operation took place in February of that year when the river began to flow through the tunnels.

Following closure of the river, a degree of ponding developed upstream of the main dam. In anticipation of this, and of later flooding, pumping installations operated by P.F.R.A. to deliver water into the Qu'Appelle River system were dismantled, together with a railway bridge crossing the river at Elbow. Sections of highway, railway, power lines and other public utilities, which would eventually be inundated by rising waters, were relocated.

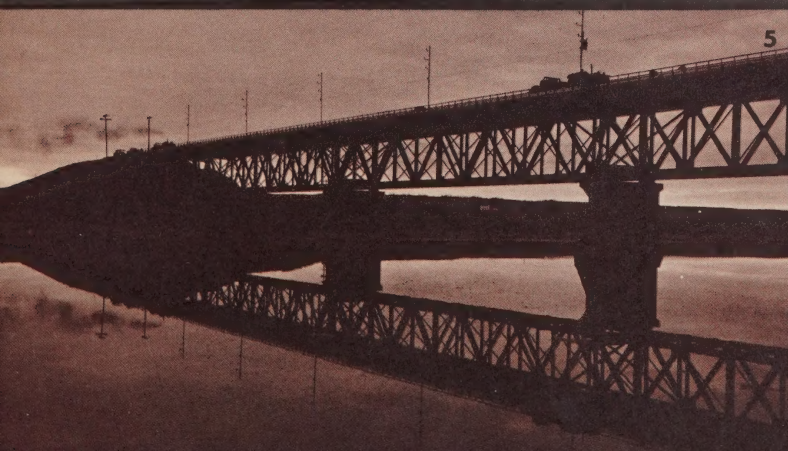
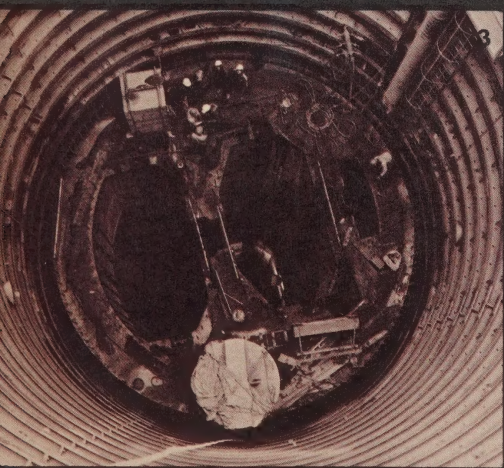
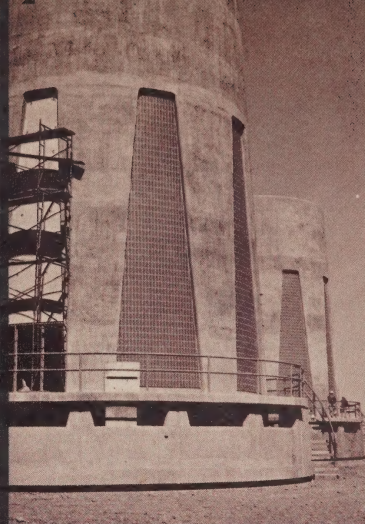
The last stage of earth construction involved the centre section of the dam across the original river channel, and raising the over-all embankment to its final height of 210 feet. The contract for this was awarded early in 1964, and apart from riprapping was virtually complete by the end of 1966.



On the spillway, construction has generally been completed except for riprapping. At the spillway crest, massive concrete piers rise to the same elevation as the top of the dam, and support a traffic bridge over the spillway. Radial gates for regulating flow down the spillway are housed between the pillars. There are 11 such gates, each 40 feet wide and 30 feet high. The spillway chute and stilling basin have been completed with only some protective work and outlet channel preparation remaining.

Work on the Qu'Appelle Dam was started late in the fall of '63 when construction was confined to a minor amount of earth and concrete work on the conduit section before winter set in. The conduit was completed during 1964 and the earthwork finished during the following two years. Placing of slope-protection riprap remains to be completed.

As the main dam neared completion, the Government of Saskatchewan proceeded with its plans for harnessing the available water which was 115 feet at its deepest point at the end of 1966. A hydroelectric power generating plant was under construction at the downstream end of the diversion tunnels, and a pumping plant was being built at the east end of the dam to raise water from the reservoir to an irrigation canal under construction. Work was also in progress on the Saskatoon Southeast Water Supply Project for the provision of water to industry and communities southeast of Saskatoon. Recreation facilities along the reservoir were also being developed.



- 1 Scraper at work.
- 2 Control shaft superstructures.
- 3 Gate wells—control shaft substructures.
- 4 Aerial view of Gardiner Dam.
- 5 Construction bridge.

ENGINEERING SERVICES

Years of investigations and intensive engineering studies have gone into building the South Saskatchewan River Project. In the planning and design a large amount of basic information was required. In this respect, PFRA has been fortunate in having trained personnel with many years of experience in the development of large structures such as the St. Mary, Waterton and Travers Dams in Alberta. In addition, wide experience has been gained in the construction of hundreds of smaller water conservation projects built by PFRA across the four western provinces.

Leadership on the South Saskatchewan River Project was originally provided by the late Gordon L. MacKenzie, Director of PFRA during the formative stages of the project's construction, and in the years previous when the project was still under investigation. At that time, Mr. MacKenzie held the position of Chief Engineer.

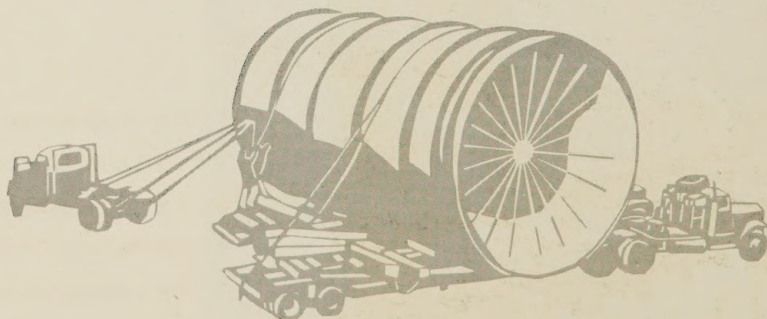
The officer presently responsible for all engineering services is J. Gordon Watson, Chief Engineer of PFRA. Assistant Chief Engineer is Walter B. Thomson who also serves as Project Engineer. He is responsible for all aspects of engineering administration and supervision of construction associated with the South Saskatchewan River Project. Senior officer in charge of construction at the damsite is A. S. Ringheim. The main sections of organization from an engineering standpoint are Surveys Division, Hydrology Division, Air Photo Analysis and Engineering Geology Division, and the Design Division.

The major planning and design work associated with construction on the project is carried out by these divisions. The offices are located at PFRA headquarters in Regina. Office and laboratory facilities for the Soil Mechanics and Materials Division are located in Saskatoon.

CONSTRUCTION HEADQUARTERS

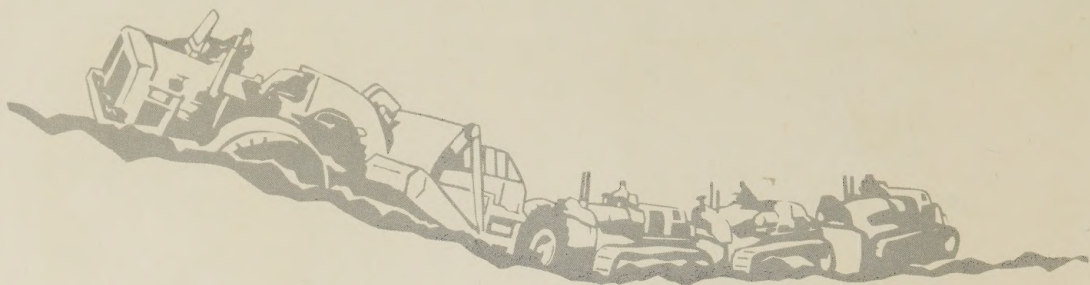
PFRA personnel at the damsite carry out all the engineering tasks associated with the construction of the project in accordance with the specifications laid down by the technical divisions. Since this requires steady and continuous inspection and supervision while the work is in progress, these people must be headquartered at the construction site. At the headquarters all necessary administrative and engineering offices required to carry out these duties are provided, together with a laboratory for the testing of soil and concrete used in construction, a garage and warehouse, a staff house for single workers and residential accommodation for married personnel. In addition, an assembly hall is provided where religious services and social functions are held, as well as technical and staff meetings.

To accommodate visitors who come to the site each year to view construction, a tourist pavilion has been built on a vantage point overlooking the construction area and is manned by qualified attendants. Since construction began in 1958, from 65,000 to 85,000 people have visited the pavilion annually.





- 1** Weighing soil samples.
- 2** Concrete-lined diversion tunnel.
- 3** Testing concrete specimens.
- 4** Surveying for construction.
- 5** Testing hydraulic model of spillway.



LIFE AT THE DAMSITE

Married personnel stationed at the site live in houses rented from PFRA, or in their own trailers within a trailer court maintained by the Administration in the headquarters area. Arrangements have been made with the Outlook School Board which permit the children to attend school in Outlook. They are transported the 24 miles to and from Outlook by a PFRA bus, with the cost being borne by the parents concerned.

The organization owns a modern fire truck and equipment which is manned by a volunteer fire brigade of PFRA employees. A room in the staff house has been equipped as a first-aid treatment room. PFRA also maintains a fully equipped ambulance and has several trained first-aid men on the staff.

Families with the private contracting firms live either in trailers located in a commercial trailer court near the construction area, or in homes in nearby towns or in trailers kept in farmers' yards. In certain cases, the contractors also maintain staff quarters for single men on serviced lots provided by PFRA. During peak construction periods, there have been approximately 1,200 workmen employed on the project with a total payroll of around \$500,000 per month.

Since construction started, several commercial enterprises have been established adjacent to the headquarters area. Building in this location is controlled by local municipal bylaws and has been given the official postal designation of Cutbank. In this area there are 3 general stores, a post office, 2 eating establishments, 2 service stations and a bank subsidiary.

Headquarters area and townsite.

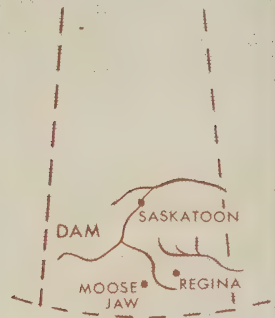


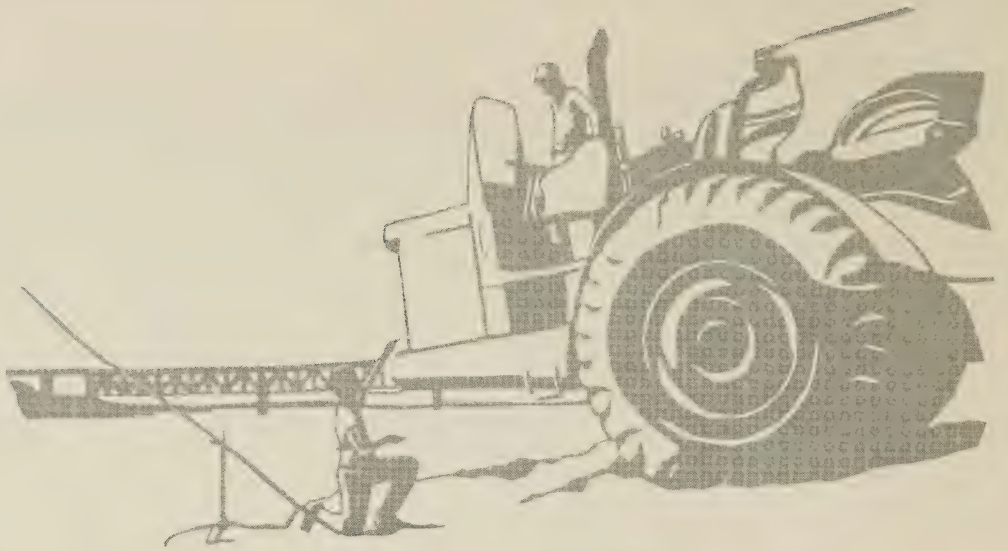
MAP OF DAM AND AREA

RESERVOIR

PROPOSED IRRIGATED AREA

KEY MAP





**Familiar scenes at
the South Saskatchewan River
Project.**

PROJECT STATISTICS

GARDINER DAM

Height.....	210 feet
Length—overall.....	16,700 feet
Width at base.....	5,300 feet
Vol. of embankment.....	85,000,000 cu. yds.
Vol. of excavation.....	110,000,000 cu. yds.
Vol. of concrete.....	630,000 cu. yds.
Vol. of rip-rap.....	450,000 cu. yds.

SPILLWAY

Type—Gate controlled concrete chute.....	
Length of chute.....	3,830 feet
Length of crest.....	528 feet
Discharge capacity.....	265,000 c.f.s.

DIVERSION WORKS

Type.....	Tunnels
No. of tunnels.....	5
Average length.....	4,300 feet
Size of tunnels.....	20 ft. dia.

RESERVOIR

Area.....	109,600 acres
Total storage.....	8,000,000 ac. ft.
Usable storage.....	2,750,000 ac. ft.
Length of shoreline.....	475 miles
Length of reservoir.....	140 miles
Depth of water at dam.....	192 feet

QU'APPELLE RIVER DAM

Height.....	90 feet
Length.....	10,200 feet
Width at base.....	1,900 feet
Vol. of embankment.....	13,500,000 cu. yds.
Vol. of rip-rap.....	275,000 cu. yds.

DRAINAGE BASIN

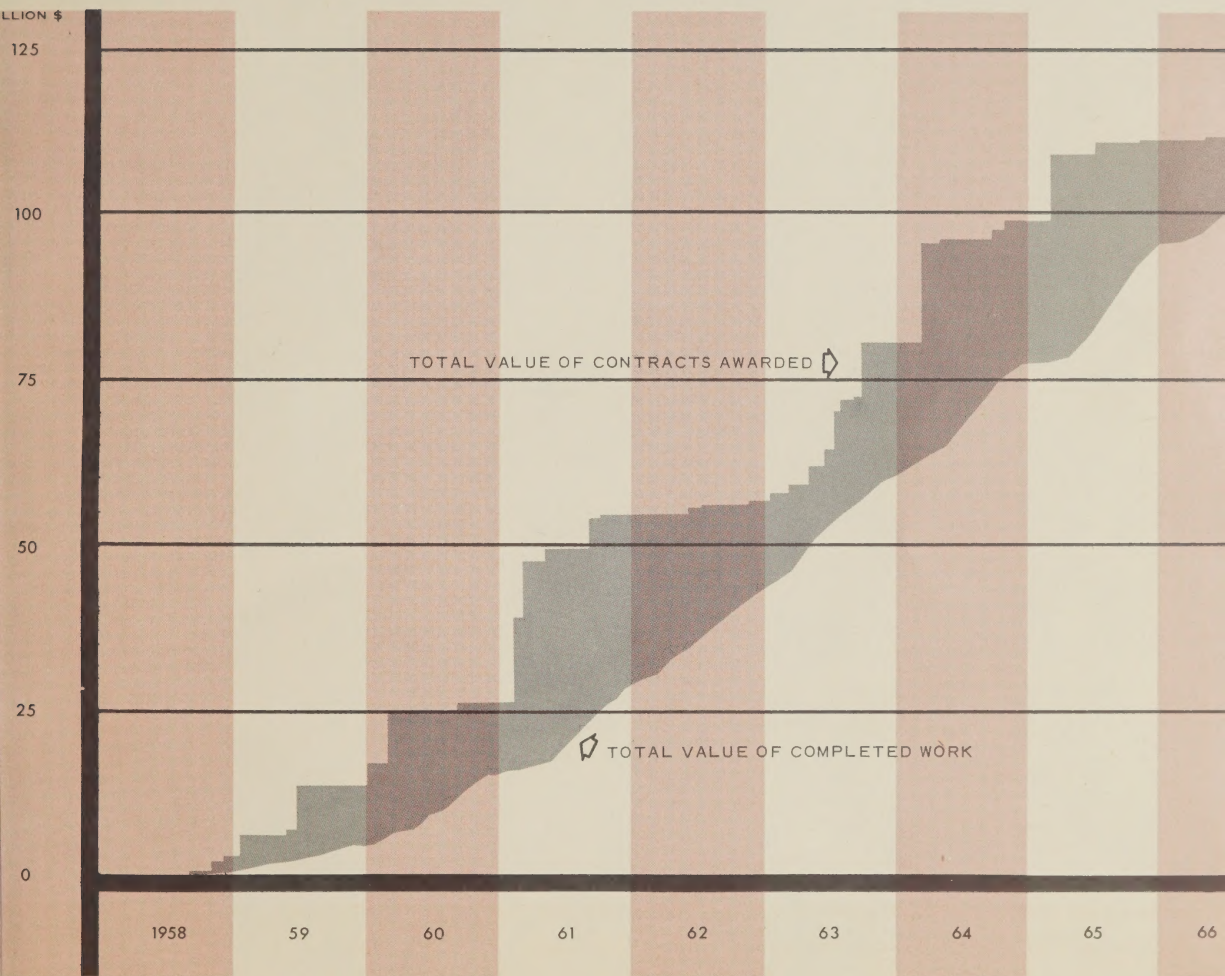
Total for river.....	65,500 sq. mi.
Above damsite.....	48,800 sq. mi.



CONTRACTS

NUMBER	NAME OF CONTRACT	CONTRACTOR	VALUE OF COMPLETED WORK
1	East Access road	Evans Construction Co. Ltd.	\$ 164,330.63
2	Aggregate processing	McNamara Ltd.	878,681.12
3	Headquarters services	Beattie Ramsay Const. Co. Ltd.	242,236.56
4	Headquarters buildings	Smith Bros. & Wilson Ltd.	743,933.73
5	Construction Bridge substructure	The Foundation Co. of Canada Ltd.	314,949.42
6	East Embankment (Stage 1)	Perini Ltd.	2,990,919.61
7	North Access road	Taylor Bros.	143,479.49
8	Construction Bridge superstructure	Bird Const. Co. Ltd.	1,044,168.38
9	West Embankment (Stage 2)	Piggott Const. Co. Ltd.	8,350,285.65
10	Headquarters water supply system	Beattie Ramsay Const. Co. Ltd.	23,392.00
11	Headquarters water supply pumps	Canadian Fairbanks-Morse Co. Ltd.	12,026.00
12	Tourist Pavilion	Bird Const. Co. Ltd.	20,771.00
13	Coteau Creek Embankment (Stage 3)	Bedford Const. Co. Ltd.	7,716,740.58
14	Downstream control tunnels	Kiewit-Johnson-Poole	8,181,862.15
15	Steel ring beams	Commercial Shearing Ltd.	2,637,250.00
16	Highway No. 45 revision	Pedersen Const. Ltd.	118,664.91
17	Highway No. 19 revision	Acorn Const. Ltd.	249,178.57
18	Cement (tunnel portals)	Canada Cement Co. Ltd.	117,008.48
19	Relief wells and conduit	Piggott Const. Co. Ltd.	242,911.04
20	Gravel highway No. 45 revision	W. F. Botkin Const. Ltd.	14,208.84
21	Upstream control tunnels	Kiewit-Johnson-Poole	8,407,452.24
22	Aggregate processing	McNamara Const. Western Ltd.	1,656,536.75
23	Gravel highway No. 19 revision	Nick Linden Const. Ltd.	35,405.35
24	Cement (tunnels)	Canada Cement Co. Ltd.	1,251,171.86
24A	Cement (tunnels)	Inland Cement Co. Ltd.	1,866,672.12
25	Tunnel control shaft substructures	Kiewit-Johnson-Poole	4,980,322.57
26	Highway No. 15 revision	Sanderson & Elgert	128,649.53
27	Tunnel outlet basin	Bedford Const. Co. Ltd.	1,067,421.63
28	Tunnel control shaft superstructures	Kiewit-Johnson-Poole	927,850.75
29	Tunnel control gates & embedded parts	Dominion Bridge Co. Ltd.	1,227,069.06
30	Steel ring beams	Saskatchewan Steel Fabricators Ltd.	515,885.55
31	Embankment (Stage 4)	McNamara Const. Western Ltd.	4,071,402.14
32	Tunnel control gate hoists	Dominion Bridge Co. Ltd.	351,404.44
33	Gravel highway No. 15 revision	South Const. Co. Ltd.	14,748.67
34	Spillway crest	Kiewit-Johnson-Poole	5,194,105.62
35	Cement (tunnels)	Inland Cement Co. Ltd.	910,983.41
35A	Cement (tunnels)	Canada Cement Co. Ltd.	911,309.59
36	*Qu'Appelle Valley Dam	E. Anderson, Square M, Coleman Collieries	8,234,736.21
37	*Spillway chute and basin	Kiewit-Johnson-Poole	8,840,550.15
38	*Embankment (Stage 5)	McNamara Const. Western Ltd.	14,849,886.07
39	Cathodic protection (Stage 1)	Cathodic Protection Service Ltd.	85,749.90
40	*Spillway gates and hoists	Canada Iron Foundries Ltd.	1,568,905.39
41	Flyash supply	Saskatchewan Power Corporation	285,398.27
42A	Reservoir clearing	North American Road Ltd.	420,381.94
43	Low level tunnel bulkheads	Falcon Engineering Co. Ltd.	55,906.18
44	Qu'Appelle control gates & hoists	Canadian Car (Pacific) Ltd.	125,600.00
45	Embankment (Stage 3A)	Standard-General Const. (International) Ltd.	944,369.12
46	*Qu'Appelle miscellaneous work	E. Anderson, Square M, Coleman Collieries	235,109.44
47	Plugging upstream tunnels	Kiewit-Johnson-Poole	419,200.79
48	Cathodic protection (Stage 2)	Cathodic Protection Service Ltd.	165,677.34
49	*Railway revision	Penner's Const. Ltd.	718,858.51
50	Cement	Inland Cement Co. Ltd.	652,020.92
50A	*Cement	Canada Cement Co. Ltd.	645,371.16
53	Aggregate processing	Thode Const. Ltd.	96,250.69
54	*Gate & hoist modifications	Dominion Bridge Co. Ltd.	23,603.91

*—Denotes final payment not yet made.





SOUTH SASKATCHEWAN RIVER DEVELOPMENT PROJECT

ROGER DUHAMEL, F.R.S.C. QUEEN'S PRINTER AND CONTROLLER OF STATIONERY, OTTAWA, 1967

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